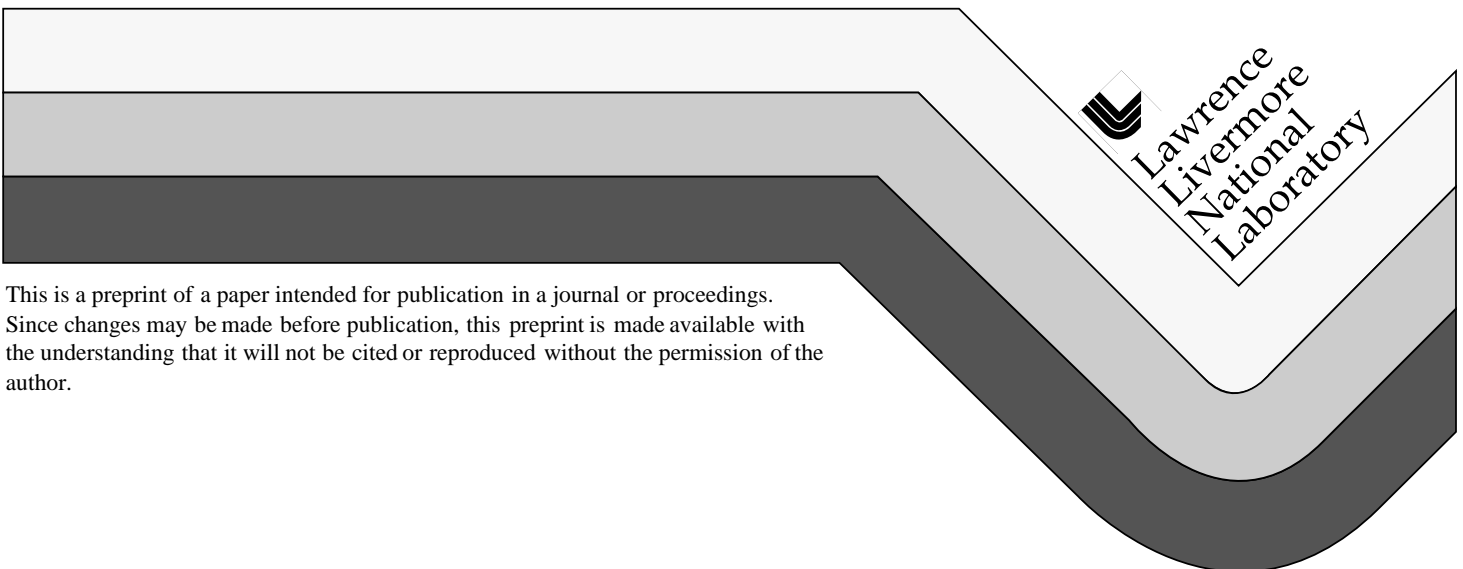


# Status and Update of the National Ignition Facility Radiation Effects Testing Program

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This paper was prepared for submittal to the  
1999 HEART ( Hardened Electronics and Radiation Technology) Conference  
Monterey, CA  
March 8-12, 1999

November 16, 1998



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# STATUS AND UPDATE OF THE NATIONAL IGNITION FACILITY RADIATION EFFECTS TESTING PROGRAM

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## ABSTRACT

We are progressing in our efforts to make the National Ignition Facility (NIF) available to the nation as a radiation effects simulator to support the Services' needs for nuclear hardness and survivability testing and validation. Details of our program were summarized in a paper presented at the 1998 HEART Conference [1]. This paper describes recent activities and updates plans for NIF radiation effects testing.

## I. INTRODUCTION

The United States Department of Energy (DOE) is currently constructing the National Ignition Facility (NIF) at Lawrence Livermore National Laboratory, Livermore,

California. The NIF's primary missions are Inertial Confinement Fusion and High Energy Density Physics research. Radiation Effects Testing, including nuclear weapons and military systems effects testing will also be one of the principal uses of NIF. Over the past few years the design of NIF has been modified and enhanced by us to allow NIF to be used as a flexible X ray and neutron source for evaluating the readiness of military systems and components to withstand radiation environments [2-5]. Much of this work has been guided by the needs and requirements of the Defense Special Weapons Agency, which has recently been renamed the Defense Threat Reduction Agency. The DOE, the National Laboratories at Livermore, Los Alamos and Sandia, Albuquerque as well as a number of DSWA contractors have joined together under the

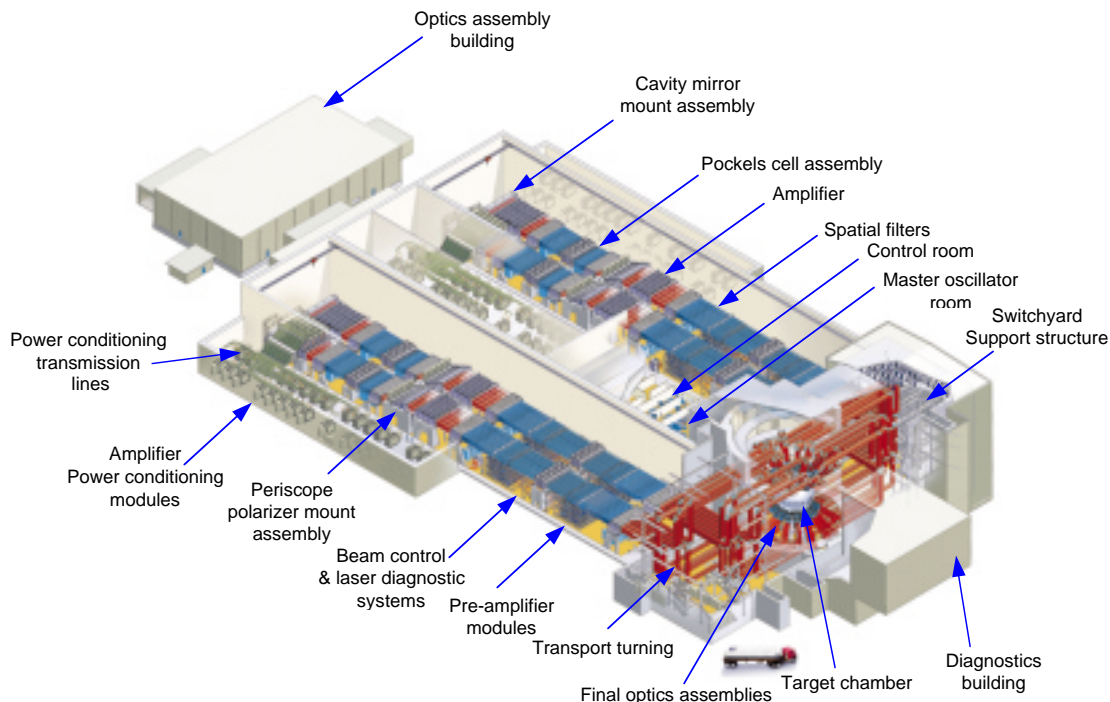


Figure 1. The National Ignition Facility is being designed to achieve inertial confinement fusion and to provide high energy density conditions for stockpile stewardship and radiation effects testing.

auspices of the NIF Radiation Sciences Users Group to develop and promote NIF as a radiation simulator for the community. Recently the NRSUG has welcomed our colleagues in the United Kingdom to participate with us in the development of large laser-based radiation effects systems.

This paper will discuss the current status of the NIF project and recent activities in support of facilitization of NIF for radiation effects testing. A separate paper presented at this conference discusses the development of new multi-keV x-ray sources for NIF based on calculations and experiments at the LLNL Nova Laser and the NRL Phebus Laser.

## II. STATUS OF THE NIF CONSTRUCTION

Figure 1 shows the layout of the NIF. NIF is planned to produce 1.8 MJ of blue ( $0.35\ \mu\text{m}$ ) light at 500 TW onto a target or targets to meet the requirements of inertial confinement fusion. The laser system consists of 192 separate beams, directed through 48 ports into a 10-meter diameter spherical target chamber. Figure 2 shows a recent photograph of the NIF construction. The main NIF building was “topped out” on August 31, 1998. The schedule calls for the target chamber to be inserted into the building in April 1999. Major facility modifications have been implemented to accommodate

radiation effects testing. For example, we have upgraded the hydraulic lift, installed at the bottom of the target chamber, to allow large test objects weighing up to 15 tons to be inserted into the NIF target chamber through a 2 m diameter port at the bottom of the chamber. In addition a large test object access port has been designed into the target chamber at the waist that allows objects up to  $\sim 1$  m in diameter to be inserted. Figure 3 shows the most recent design of the NIF Target Area. The floors have been strengthened to allow load-bearing capability up to 4500 kg. Electrical power, low noise grounding and shielding, diagnostics interfaces and vacuum systems have also been added in the target chamber area in support of radiation effects testing. Pre- and post-shot support areas will be available as well as a dedicated screen room for data acquisition located in the Diagnostics Support Building, which can be seen in relation to the target chamber area in Fig. 1.

## III. TARGET ARRAYS FOR RADIATION EFFECTS

We have been continuing to develop the necessary flexibility in NIF to allow independent targeting of NIF beams for distributed arrays of x-ray sources. This requires that we place optics into the NIF Final Optics



Figure 2. Photograph of NIF construction taken in September 1998. The NIF target chamber area is located in the lower left corner of the photograph.

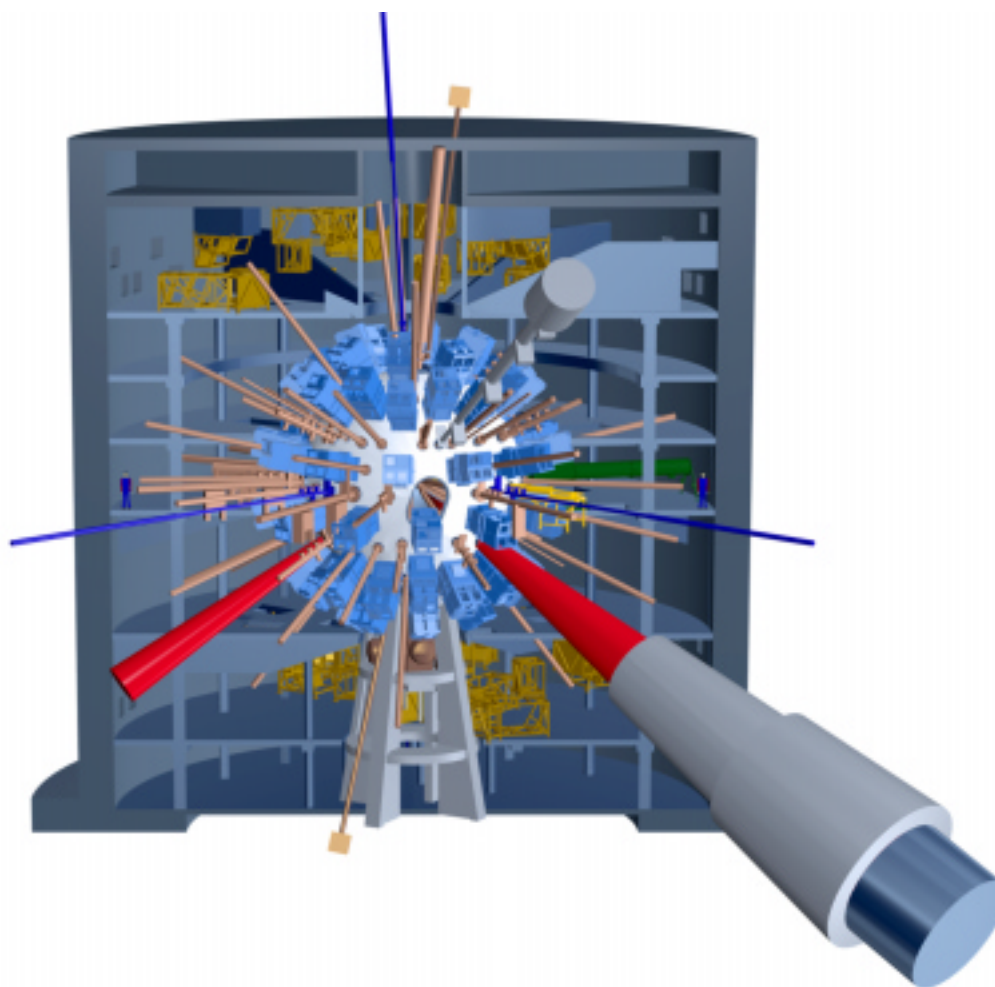


Figure 3. NIF 10-meter target chamber showing various x-ray and neutron diagnostics. Note large test object insertion port at the center of the picture. A 15-ton hoist is located at the bottom of the pedestal.

Assemblies (FOA) to steer the beams off target chamber center and onto target arrays of various sizes and shapes. Figure 4 shows a notional view of one such array. NIF's design allows up to 48 independently targetable x-ray sources that can be distributed spatially and temporally. This allows for interesting radiation effects testing environments including shaped x-ray pulses, composite x-ray spectra for better fidelity, intensity tailoring for uniformity of fluence and spatial tailoring to match complex test object geometries.

Our major thrust in FY99 is to develop the necessary diffractive beam steering optics and to design source arrays to offer a variety of exposure profiles while preserving relatively light-free areas of the target chamber for placement of test objects. We are currently developing computational visualization tools to couple to CAD engineering design software to allow assignment of NIF beams to particular x-ray sources.

#### IV. CONCLUSIONS

The NIF is being designed to produce test environments of interest to the radiation effects testing community. The NRSUG continues to provide guidance to the NIF Program with the support of DTRA, the National Labs and DOE to ensure that radiation effects test needs are implemented on NIF. We are anticipating that radiation effects tests will be among the first to be performed on NIF when first beams become available in late 2001 and will continue to be a major use of the facility during commissioning through 2002-2003. In addition to nuclear weapons and military systems testing we expect that NIF can provide interesting environments for shock effects experiments including the generation and propagation of single and multiple strong shocks in bulk geologic materials, air blast and cratering phenomena and radiation hydrodynamic flow in complex structures.

**Multiple  
Sources**

**Test  
Object**

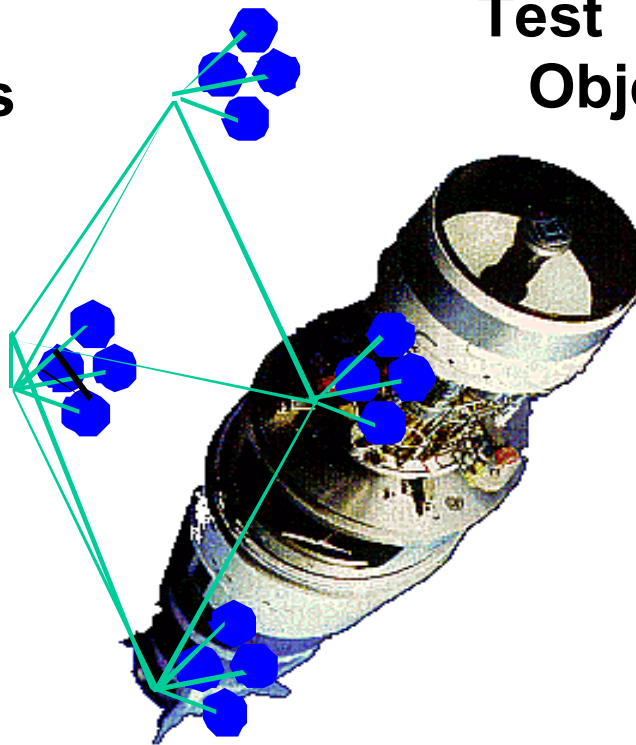


Figure 4. Schematic of 16 laser plasma x-ray sources distributed over a test object to achieve maximum fluence while maintaining good uniformity. The source array is approximately 50 cm on a side. The x-ray sources are shown much larger than their actual size of a few millimeters for clarity.

The NRSUG has recently formed the NIF Effects Organization (NEO) to provide the link between the NIF and the radiation effects community. NEO will provide program oversight and perform a host role for radiation effects users on NIF. We encourage interested researchers to contact the principal author of this paper for more information on implementing radiation effects tests on NIF.

## ACKNOWLEDGEMENTS

The authors would like to acknowledge the support of the members of the NIF Radiation Sciences Users Group. This work has been performed under the auspices of the US Department of Energy by the Lawrence Livermore National Laboratory contract W-7405-ENG-48 and the Defense Threat Reduction Agency, IACRO # 98-3064 Work Units 57424 and 57425.

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